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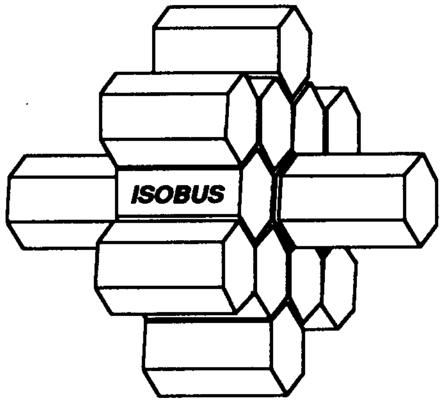
ISOBUS

A New Versatile Spacecraft Platform Using Shuttle Small Payloads



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EXECUTIVE SUMMARY

The new NASA credo of "faster, better, cheaper" calls for a new generation of smaller and less complex spacecraft. In response to this challenge, many new spacecraft concepts - generally characterized as mini- or micro-spacecraft to reflect their significantly smaller size - have been generated within NASA, industry, and academia. The Jet Propulsion Laboratory (JPL), Rockwell International Space Systems Division (Rockwell), and the Space Dynamics Laboratory (SDL) / Utah State University (USU) are jointly examining one such new spacecraft concept, hereafter termed ISOBUS, which is derived from recent research and development work in isogrid structures conducted by SDL/USU for JPL's Microspacecraft Development Program. ISOBUS' design is based on a six-sided hexagon shaped structure. Two prototypical products from SDL/USU's work are ISOSPACEPAK (a modular Shuttle Small Payload experiment rack) and ISOSAT (a microspacecraft structure). These hexagon shaped elements serve as building blocks for the ISOBUS spacecraft concept.

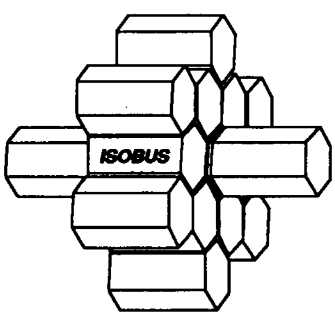
ISOBUS pushes the frontier of Shuttle Small Payload applications. Circumventing the limitation posed by the 5 cubic feet user-volume of the single Get Away Special canister (GAS can), ISOBUS employs an assembly of GAS can compatible modules in order to achieve a more capable spacecraft (see Figure-1). Each ISOBUS module may be transported into orbit in a GAS can employing a sealed door assembly, or all the modules could be transported collectively in the Rockwell designed Orbitus carrier employing a mechanized door assembly. Once on orbit, the GAS cans or Orbitus carrier would be opened and the ISOBUS modules, sitting in vacuum and still electrically connected to the Shuttle's Aft Flight Deck (AFD), would undergo functional checks. Key ISOBUS modules with post-launch anomalies would be identified and could possibly be replaced by an on-board spare prior to spacecraft assembly. Assembly of the ISOBUS spacecraft from its individual modules would take place on an "assembly/spin table" employing the cross-bay Mission Peculiar Equipment Support Structure (also known as the GAS Bridge), or the Rockwell developed Lightweight Payload Carrier. On-orbit assembly tasks would be telerobotically performed using the Shuttle's Remote Manipulating System (RMS) with the newly developed Dexterous End Effector (DEE). The Servicing Aid Tool's (SAT) slave robotic arm may also be employed. Finally, an Interface Verification Test (IVT) of the completely assembled ISOBUS spacecraft would be achieved from the AFD to be followed by Shuttle deployment using the RMS-DEE or ejection by the assembly/spin table. The lower end of each ISOBUS module would employ a standardized electrical connector which satisfies interface requirements for on-orbit robotic servicing. The upper end of each ISOBUS module would employ a standardized mechanical interface for grappling by the DEE and perhaps the SAT. The sides of each ISOBUS module would employ standardized mechanical, electrical, and fluid connectors to interface with adjacent ISOBUS modules.

ISOBUS presents new approaches to maximizing Shuttle Small Payload utility. ISOBUS allows better utilization of the Shuttle's precious "real-estate." GAS cans, containing the ISOBUS spacecraft modules, could be mounted in various locations in the Shuttle's cargo bay between the primary payloads (off cross-bay bridge structures or the cargo bay side-wall). The Orbitus carrier option is also flexible and efficient by being compatible with any of bays 2 through 13 and occupying only one full bay. Compatibility of ISOBUS modules with the DEE for on-orbit robotic assembly would improve ground handling and installation of the ISOBUS modules just prior to launch. A ground support version of the DEE could be employed at the launch pad with a ground-based

robotic slave arm. The ISOBUS modules, like Line Replaceable Units (LRU), could be telerobotically slipped-in or changed-out of their GAS cans or Orbitus carrier just prior to launch. This provides flexibility and late payload access not only to the payload-user (i.e. for short-life biological specimens), but also to NASA's cargo integration discipline (i.e. for "Smart Ballast" installation). In addition, the LRU-like nature of the individual ISOBUS modules lends itself to externally mounted Space Station payloads, which can be delivered, installed, and removed using the Shuttle and its RMS-DEE. ISOBUS eliminates large complex integrated spacecraft structures which have to withstand launch vibration and loads; because the individual ISOBUS modules are packed, supported, and protected in their individual GAS cans or collectively in the Orbitus carrier. Lastly, the modular ISOBUS approach lends itself to faster and cheaper development of spacecraft, since each instrumentation package or system would be built by the corresponding contractor directly into the standardized ISOBUS module structure, then delivered to a payload depot at Kennedy Space Center for ground IVTs with other modules, and then launched and assembled on orbit.

The ISOBUS spacecraft would provide a versatile platform for diverse space users and sophisticated missions. Multiple principal investigators requiring lower levels of micro-gravity, cleaner vacuum environments, or longer stays on-orbit could have their individual experiments (each packaged in an individual ISOBUS module) assembled on-orbit into an ISOBUS cluster of experiments. This cluster would then be deployed away from the Shuttle for the duration of the mission (like Spartan) or left on-orbit for an extended stay (like LDEF). In either case, deployment and retrieval of such a cluster of multiple experiments should be cost-effective to both NASA and the experimenters. Other cost-effective applications for the ISOBUS are DoD strategic surveillance missions; civilian Earth observation missions; and with attachment of appropriate propulsion capability, lunar, near Earth objects (asteroids / comets), and perhaps interplanetary probe missions. Moreover, upon arrival at the mission's destination (i.e. a cometary tail or a planet) an ISOBUS spacecraft-cluster could separate into a network of individual science probes (each being an individual ISOBUS module).

ISOBUS introduces a new, innovative, "faster, better, cheaper" approach for space utilization and exploration, using our existing Space Shuttle Program and Shuttle Small Payloads infrastructure. ISOBUS also presents new commercial opportunities for standardizing various spacecraft subsystems for integration into ISOBUS modules (i.e. command & control, power, propulsion, navigation, instrumentation, data collection, communication, etc.). In essence, a large variety of ISOBUS modules could become available, providing cost-effective, off-the-shelf building blocks for future spacecraft. Lastly, ISOBUS provides NASA with an effective, near-term opportunity to gain experience and exercise on-orbit assembly tasks, serving as precursors to more complex future on-orbit assembly of spacecraft such as a manned Earth-to-Mars orbital transfer vehicle.



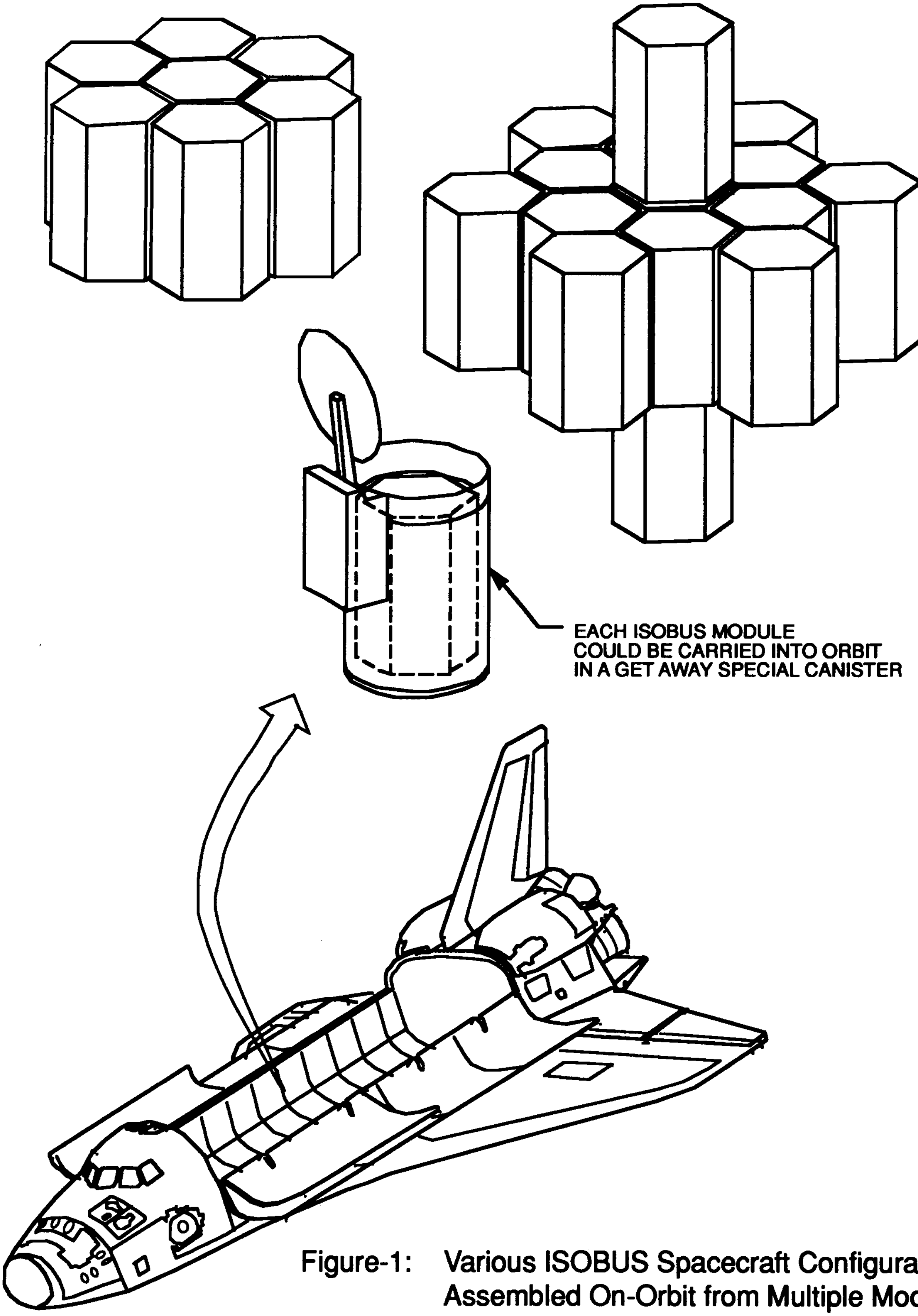


Figure-1: Various ISOBUS Spacecraft Configurations Assembled On-Orbit from Multiple Modules